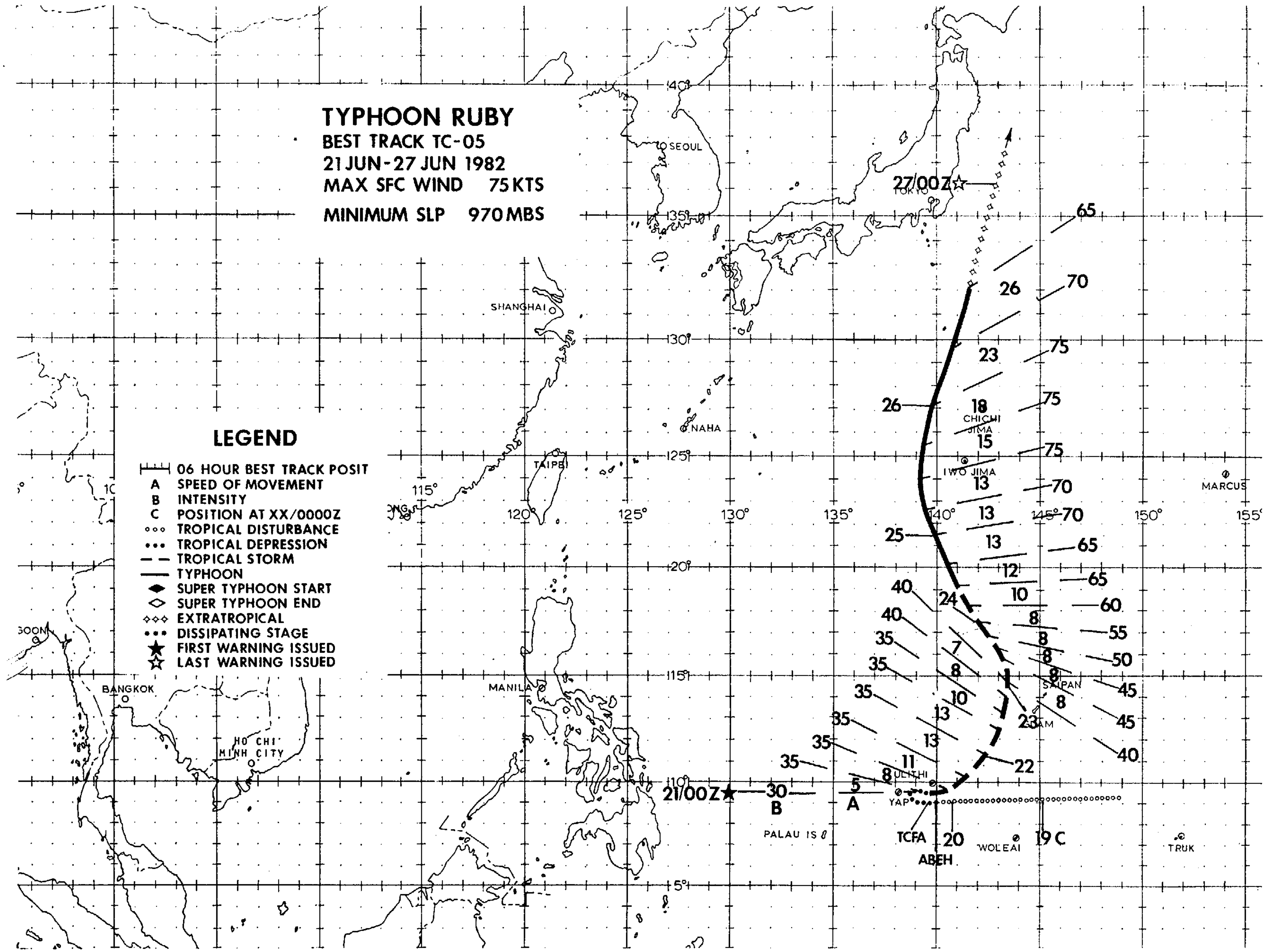

TYPHOON RUBY
BEST TRACK TC-05
21 JUN-27 JUN 1982
MAX SFC WIND 75 KTS
MINIMUM SLP 970 MBS
LEGEND
06 HOUR BEST TRACK POSIT
A SPEED OF MOVEMENT
B INTENSITY
C POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
DISSIPATING STAGE
FIRST WARNING ISSUED
LAST WARNING ISSUED
SEOUL
SHANGHAI
TAIPEI
NAHA
MANILA
BANGKOK
HO CHI MINH CITY
TOKYO
CHICHI JIMA
IWO JIMA
MARCUS
SAIPAN
ULITHI
YAP
PALAU IS
WOLEAI
TRUK
TCFA
ABEH
27/00Z
21/00Z

Typhoon Ruby developed from a convective disturbance which was initially detected southeast of Guam on 18 June. During the first ten days of Ruby's development, its track and eventual extratropical transition were dramatically affected by several events which can be traced to fairly rapid changes in the upper-troposphere. These events will be discussed individually as they occurred during Ruby's lifespan; however, collectively, they illustrate the need for a better understanding of the upper-troposphere and its effects on subsequent tropical cyclone development and movement.

Satellite imagery, on 18 June, located a weak convective disturbance 320 nm (593 km) southeast of Guam. During the next 24 hours, this disturbance was observed tracking westward to near 145E where it weakened significantly while an upper-level anticyclone, previously supporting the convection, receded to a position east of 150E. On 20 June, a cloud cluster developed near 9N 141E and continued moving westward, south of Ulithi Atoll (WMO 91203). A Tropical Cyclone Formation Alert was issued upon receipt of Ulithi's 200600Z surface observation which reported a six-hour pressure fall

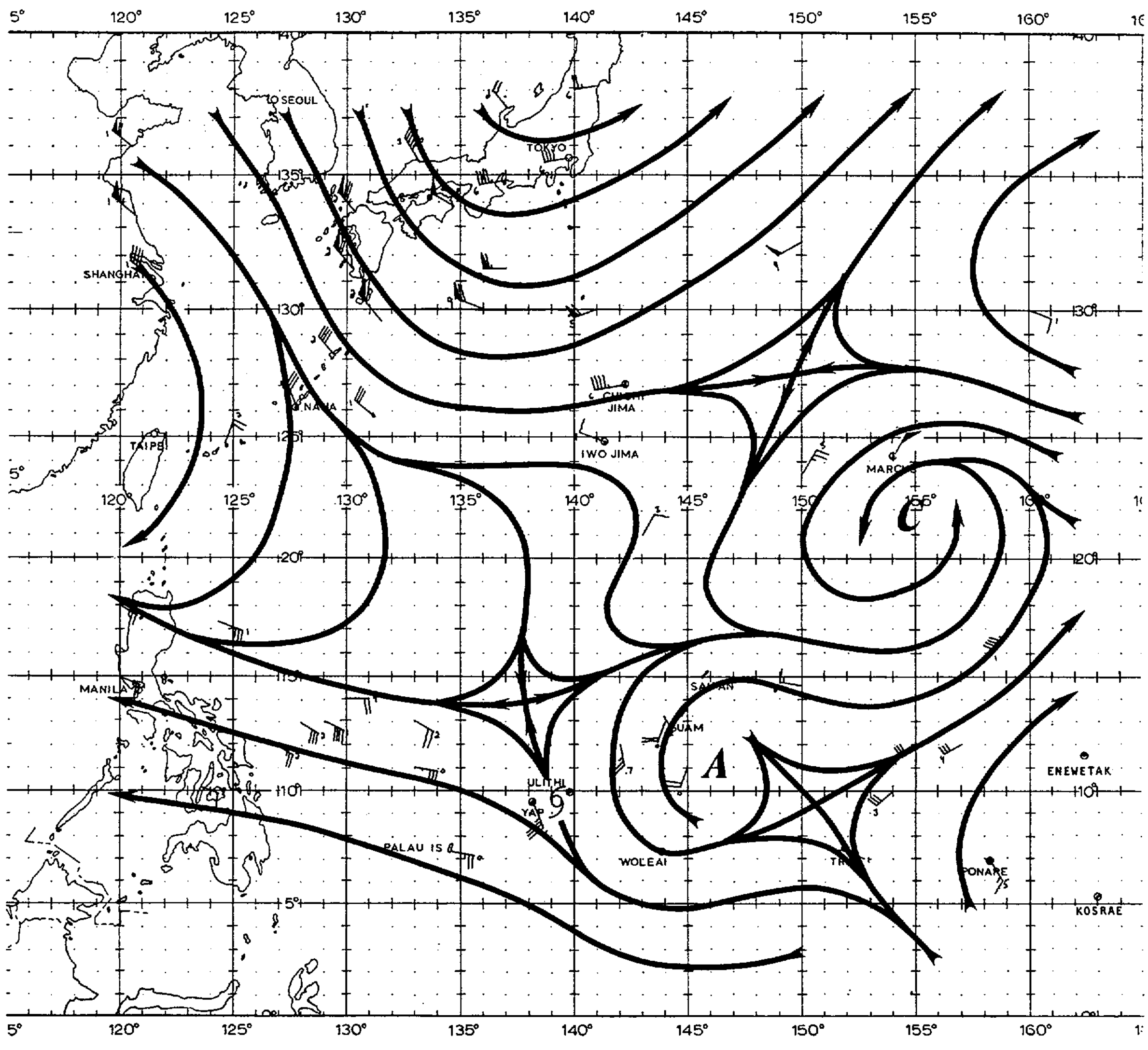

Figure 3-05-1. 210000Z June 1982, 200 mb streamline analysis. Ruby, positioned within a divergent southerly flow, was maintaining a central convective feature. To the north, a broad northerly flow was beginning to influence the near-storm environment. Wind speeds are in knots.

of 5 mb to 1004 mb, and a windshift from 030 degrees at 20 kt (10 m/sec) to 100 degrees at 25 kt (13 m/sec).

During the next 42 hours, satellite imagery and synoptic data indicated very little westward movement, with the system moving erratically between Yap and Ulithi. At 202339Z, the first aircraft reconnaissance mission into the system located a well-defined, very compact, 995 mb circulation center 45 nm (83 km) west-southwest of Ulithi. Based on these data, the first warning was issued for Tropical Storm Ruby at 210000Z with a forecast track toward the west-northwest. This forecast track was based on a very close agreement in most objective forecast aids. In fact, only the 700 mb and 850 mb steering aids, which indicated south-eastward low-level steering, did not support this initial forecast movement. The apparent conflict between low-level and mid-level steering was seen as a reason for Ruby's erratic movement; but at that point, the long-term potential for a west-northwestward track looked good. At 210830Z, an aircraft fix located Ruby 35 nm (65 km) south of Ulithi; this fix was in good agreement with Ulithi's 210600Z observation. Unfortunately, the 210600Z observation would be the last received from Ulithi for 24 hours. During the next 18 hours, fix positions from infrared satellite imagery showed Ruby moving northward, then northwestward, passing over Ulithi. Without sufficient synoptic data to the contrary, the next few warnings followed these satellite positions and maintained the forecast track toward the west-northwest.

However, on this first day in warning status, the upper-level wind regime near Ruby was changing. As depicted in Figure 3-05-1,

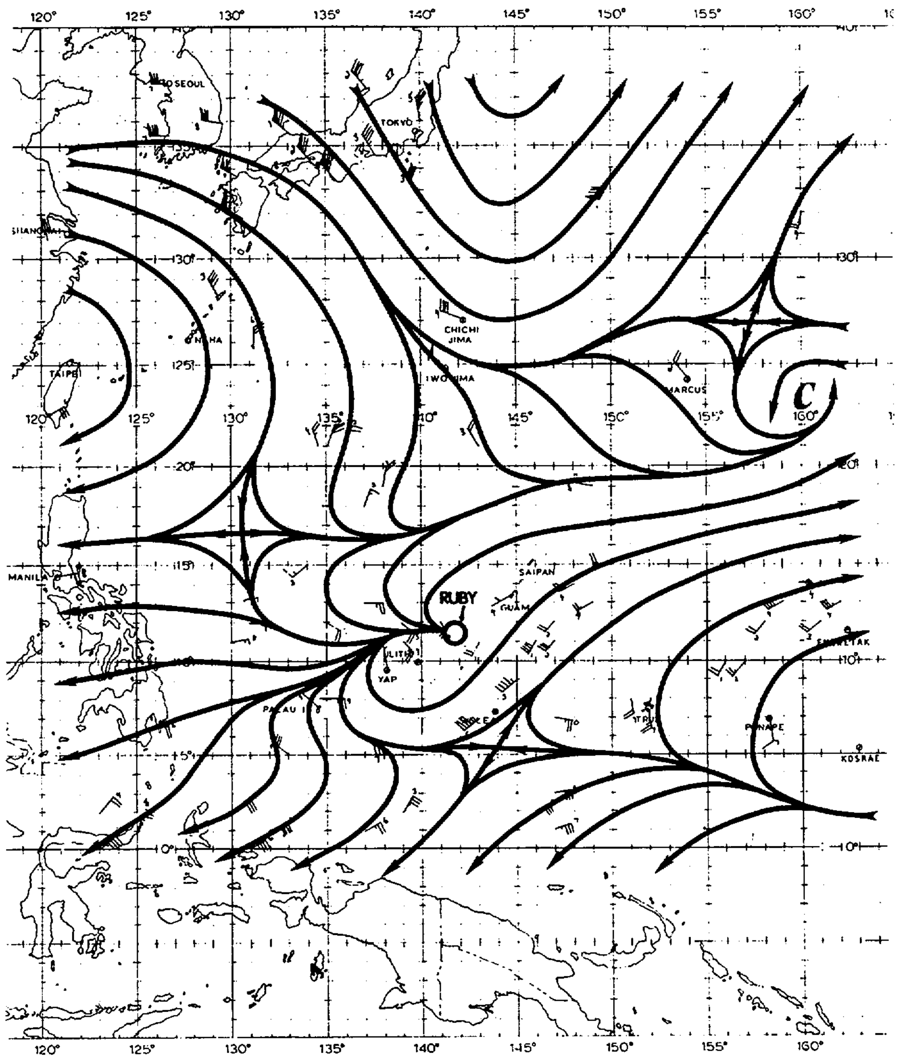

Figure 3-05-2. 220000Z June 1982, 200 mb streamline analysis. Considerable change has occurred in a 24-hour period. The northerly winds have penetrated to 10N, where the base of an upper-level trough formed. Coincident with this trough, a maximum cloud zone developed over the area south of Ruby's position and near-gale force winds were observed over a broad area at the surface and gradient levels near the upper-level trough/maximum cloud zone. Wind speeds are in knots.

the 200 mb winds at 210000Z were strongly divergent over Ruby but a broad mid-latitude trough, south of Japan, was introducing a significant northerly flow into the region. By 220000Z, the 200 mb winds (see Figure 3-05-2) had changed and an upper-level trough had set up south of 10N, and south of Ruby. While this process was underway, the objective forecast aids - especially the tropical cyclone models - were predicting a return to a westward track while analyses data were indicating a strengthening of the monsoon flow, located southeast and southwest of Ruby. When the first visual satellite imagery became available on 22 July, a low-level circulation center was seen embedded in a maximum cloud zone which had developed over the monsoon flow. This circulation, presumed to be Ruby, was located near 11N 142E, or more than 200 nm (370 km) from the 210000Z warning position. The 220000Z warning was immediately amended and a forecast track to the northeast, toward Guam, was issued. Interestingly, this amended warning had an exact 24-hour forecast position and only a 57 nm (106 km) error at 48-hours; but more importantly, a similar set of forecast errors could have been produced as early as 210600Z if the development of an upper-level trough and associated surge in the southwest monsoon could have been predicted from the 210000Z upper-wind flow analysis. This northeastward movement has become a familiar pattern in years past when developing tropical cyclones become involved with an intensifying southwest monsoon. For recent examples, refer to past ATCRs describing Tropical Depression 16/Typhoon Orchid (1980), Tropical Storm Thelma/Typhoon Vernon (1980), Tropical Depression 11/Tropical Storm Phyllis (1981), and Typhoon Gay (1981).

As Ruby moved northeastward toward Guam, its intensity remained near 35 kt (18 m/sec). During this period, much of Ruby's circulation pattern was involved with the monsoonal flow and the strongest winds were observed within the maximum cloud zone associated with this flow. Not until 23 June, when Ruby turned northward and became a separate entity from this maximum cloud zone, did its surface pressures fall and intensity increase.

Although the best track might suggest a rather steady increase in both Ruby's intensity and speed of movement from 23 through 25 June, these days were marked by often conflicting fix data. For example, the 240445Z visual satellite imagery (refer to Figure 3-05-3) indicated an exposed low-level circulation center near 19N 142E, while a

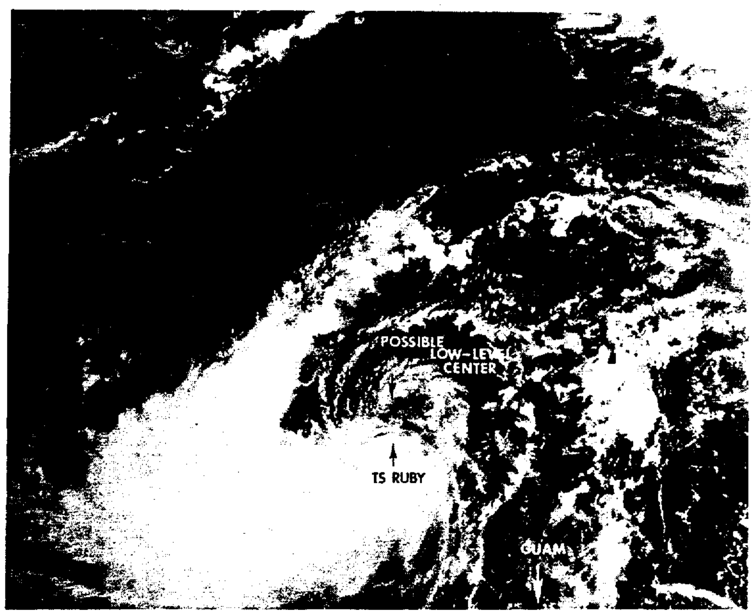

Figure 3-05-3. Visual satellite imagery suggested a low-level circulation center located in the northern periphery of the cloud system. This apparent low-level center was located well-north of a aircraft position received more than 3 hours later. 240445Z June 1982 (NOAA 7 visual satellite imagery).

reconnaissance aircraft surface/700 mb fix, at 240809Z, found a center nearly 60 nm (111 km) to the south. On 25 June, the 250630Z and 250911Z 700 mb aircraft fixes were positioned in a way to suggest either erratic movement or multiple circulation centers. These phenomena have been observed in other tropical cyclones which have emerged from an active monsoon flow. Typhoon Orchid (1980) had a sufficient amount of satellite, aircraft and radar fixes to suggest a high speed looping pattern over a 30-hour period. Ruby's intensity during this period was equally hard to determine. Intensity estimates derived from visual satellite imagery (Dvorak, 1973) and minimum sea level pressures (Atkinson and Holliday, 1977) were normally separated by 15 to 25 kt (8 to 13 m/sec), with the pressure consistently lower than expected during this period. In post-analysis, both the track and the intensity trend have been smoothed by a careful reevaluation of the data during this period.

As Ruby moved north-northwestward, the potential for recurvature, significant acceleration and extratropical transition became increasingly important. Based on a series of evaluations from the 240000Z, 241200Z and 250000Z 200 mb charts, 24N was consistently identified as the best latitude for initial acceleration into the mid-latitude westerlies (Typhoon Acceleration Prediction Technique (Weir, 1982)). A persistent and strong west-southwesterly 200 mb flow over Japan gave an indication for the potential of recurvature toward the northeast and, based on the mean latitudes of recent mid-latitude low pressure systems and ocean sea surface temperature fronts, 35N was deemed to be a favorable latitude for extratropical transition. Figure 3-05-4 depicts the 251200Z 200 mb flow with Typhoon Ruby near 24N. Within 18 hours, Ruby had assumed a north-northeastward track and accelerated to 23 kt (43 km/hr). The 260000Z 200 mb analysis (Figure 3-05-5)

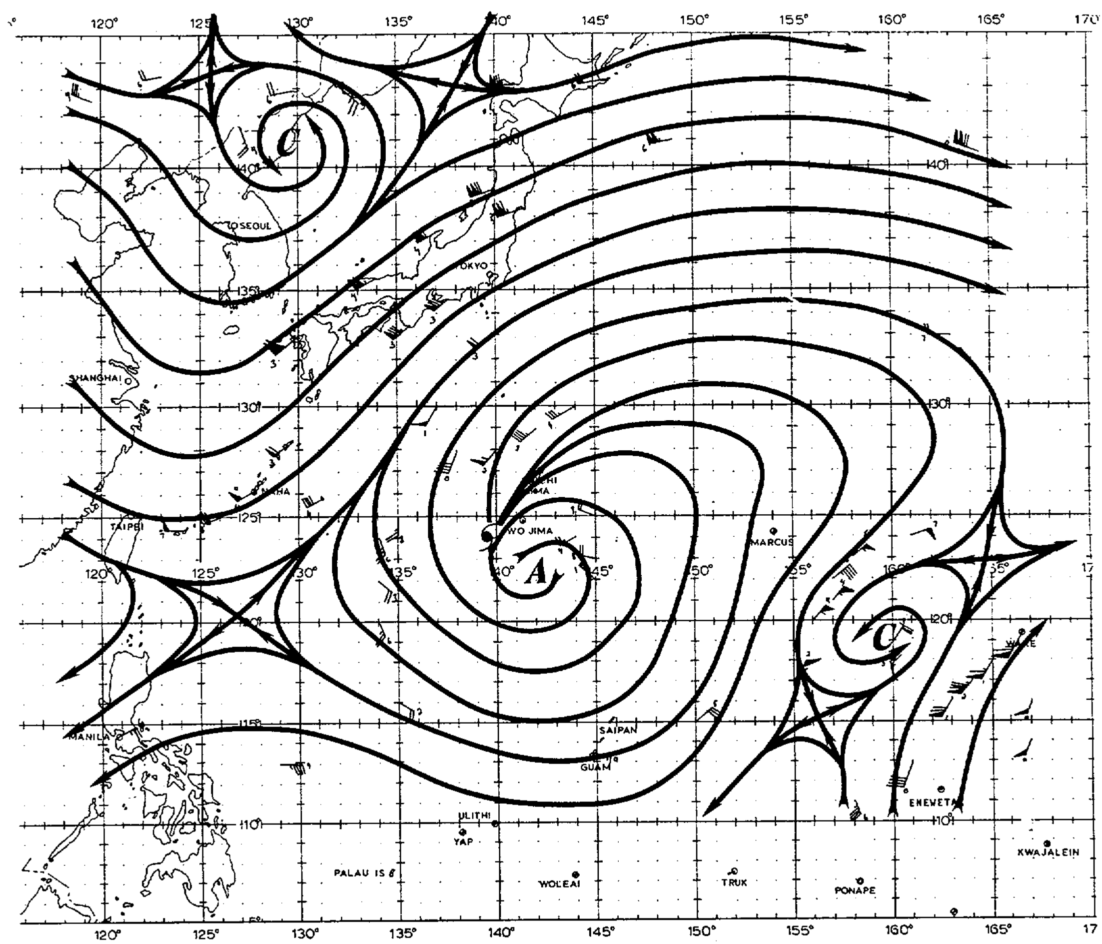

Figure 3-05-4. 251200Z June 1982, 200 mb streamline analysis. Typhoon Ruby was becoming involved with the upper-level mid-latitude westerlies. Wind speeds are in knots.

showed a dramatic change in the upper-wind pattern over Japan; 200 mb winds had become south-southeasterly and thus, signalled the potential for a more northward track. However, visual satellite fixes indicated a continuing tendency toward the northeast and the northeast forecast track was maintained. The 260602Z reconnaissance aircraft fix located Ruby's low-level circulation center 70 nm (130 km) west of the 260600Z warning position and these data, along with the 200 mb winds, dictated an amended warning toward the north-northeast and passing just east of northern Honshu.

A similar shift in the 200 mb flow also occurred with Typhoon Thad (August, 1981) and as Ruby approached the mid-latitude westerlies, the potential for such a shift was being closely monitored. Unlike Thad, Ruby quickly transitioned to an extratropical low and this movement and upper-wind shift may have been associated with that process more than any large-scale changes in the upper-troposphere.

The final tropical cyclone warning for Ruby was issued at 270000Z, after the 262149Z aircraft fix data indicated a cold core low was present at 700 mb. As an extratropical low, Ruby continued to move toward the north and rapidly occluded, becoming nearly stationary east of Hokkaido for several days thereafter.

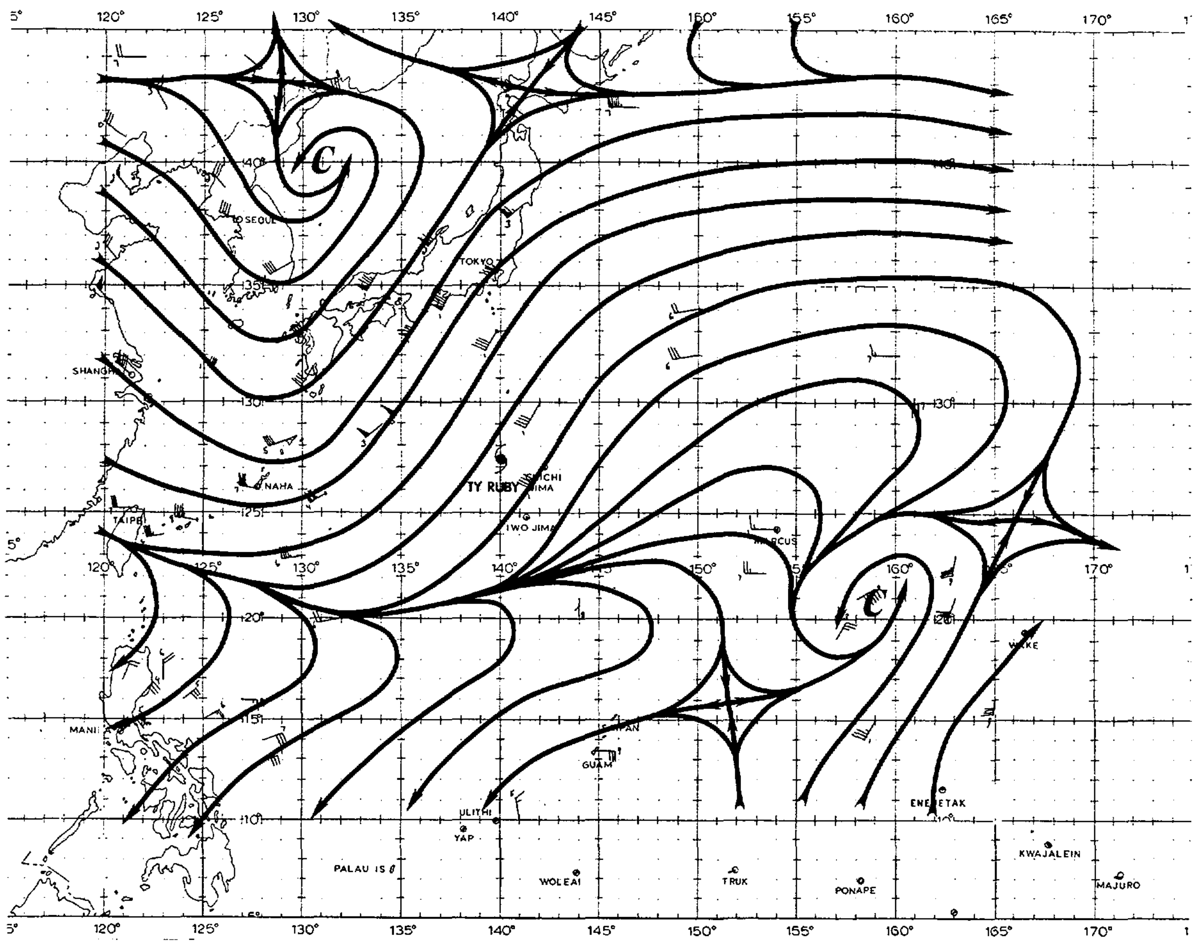

Figure 3-05-5. 260000Z June 1982, streamline analysis. Typhoon Ruby was well-embedded in the mid-latitude flow. Note the significant change in the 200 mb wind pattern over Japan in just 12 hours. This change, along with Ruby's rapid extratropical transition produced an extended north-northeastward movement and not the northeastward track predicted earlier from the 200 mb flow depicted in Figure 3-05-4. Wind speeds are in knots.